

NASA Technical Memorandum 81370

AIRCRAFT INTERROGATION AND DISPLAY SYSTEM:

A GROUND SUPPORT EQUIPMENT FOR DIGITAL FLIGHT SYSTEMS

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National Aeronautics and  
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## INTRODUCTION

The National Aeronautics and Space Administration (NASA) is conducting research in many areas involving advanced digital systems for both manned and unmanned aircraft, and in ground-based simulators. As these various types of digital flight systems have become more complex, the need has arisen for more sophisticated ground support equipment (GSE) for systems integration, software verification and validation, pre- and postflight testing, and system maintenance. Until recently, the approach taken was for each project to procure special purpose GSE, resulting in a multiplicity of different types of equipment of varying capability. These types of GSE generally were single purpose and were surplussed at the termination of the project. Usually, none of the GSE development investment could be recouped for the next project.

As an approach to a resolution of this problem, the NASA Dryden Flight Research Facility undertook the development of a microprocessor-based user-programmable general purpose GSE, termed aircraft interrogation and display system (AIDS). A prototype was constructed, interfaced with the F-8 digital fly-by-wire (F-8 DFBW) iron bird simulator, and used successfully to support F-8 flight software verification and validation. The general purpose utility of the AIDS was confirmed when applied to the highly maneuverable aircraft technology (HiMAT) project. Using new software, the prototype was easily interfaced with the HiMAT aircraft, and it quickly demonstrated its capability by providing a fortyfold increase in random access memory (RAM) data display bandwidth.

The utility of the AIDS during HiMAT flight control computer testing and systems integration validated the flexibility of the system and led to plans to apply it to other projects. Two AIDS systems are in service, and a third is under construction. The total number of present and planned users is five. This paper describes the AIDS design and mechanization, summarizes operational experience to date, and discusses plans for the future.

The use of trade names or names of manufacturers in this report does not constitute an official endorsement of such products or manufacturers, either expressed or implied, by the National Aeronautics and Space Administration.

## SYMBOLS AND ABBREVIATIONS

A/D	analog-to-digital converter
AFTI	advanced fighter technology integration
AIDS	aircraft interrogation and display system
ARW	advanced research wing
ASCII	American standard code for information interchange
ASEG	absolute segment
C&D	controls and displays
CPU	central processing unit

CRT	cathode ray tube (display)
CSEG	control segment
DAC	digital-to-analog converter
DAST	drones for aerodynamic and structural test
DFBW	digital fly-by-wire
DSEG	data segment
DSPM	dispersed sensor processing mesh
GSE	ground support equipment
HiMAT	highly maneuverable aircraft technology
HSMU	high speed math unit
I/F	interface
I/O	input/output
KB	keyboard
LED	light-emitting diode
MDS	microprocessor development system
PROM	programmable read-only memory
RAM	random access memory
RTMTX	real-time multitasking executive
STC	system test console
TTL	transistor-transistor logic
USART	universal synchronous/asynchronous receiver-transmitter

#### EXPERIENCE WITH SPECIAL PURPOSE GSE

A significant amount of experience was gained during the F-8 DFBW program in the formulation and use of display and driver GSE devices for flight control design, development, verification and validation, troubleshooting, maintenance, preflight testing, and research experimentation (ref. 1). The ground display software was implemented in the F-8 DFBW flight computer itself and consisted of several dedicated and special purpose displays, including system redundancy management status, dynamic sensor data, aircraft system status, failure status, and preflight test and maintenance results.

Although the display system was highly refined and was a key element in the successful development of the fly-by-wire system, it had several drawbacks. First, the display system was designed to operate integrally with the triple-redundant digital fly-by-wire control system, and as such it had to be nonintrusive; that is, the display functions could not alter flight control system operation. This complicated the display system software. Second, the display system required a modest but not negligible share of the flight computer cycle time and memory resources. Third, the display software required a relatively high level of verification because it resided in the flight computer, even though it was never executed in flight. Finally, the system was not portable, and it could not be used on other aircraft programs.

The driver software used for verification and validation tests, such as triplex sensor fault detection, isolation, and recovery, was implemented in the mainframe computer used for aerodynamic simulation. Special purpose pulses, waveforms, and noise signature signals were generated by the driver software and interfaced to the flight computer sensor input processor. Although highly successful, this approach required substantial amounts of simulation computer time for relatively simple computational tasks at a time when the simulation computer served multiple users.

The experience, advantages, and disadvantages of the various approaches used on the F-8 DFBW program, as well as other flight system research projects, laid the foundation for the AIDS design.

## DESIGN OBJECTIVES

The AIDS was originally conceived as a stand-alone general purpose ground support equipment device for aircraft digital flight control systems that had the display and driver capabilities of the GSE used for the F-8 DFBW. Early in the conceptual design it was determined that many other applications would be possible for this device. For that reason, design objectives were established that would guarantee the system's generality and flexibility. These design objectives included:

**Mobility.** The system should be capable of being moved between laboratories, iron bird, and aircraft.

**Flexible input/output.** The system should be easy to interface with digital and analog systems, be independent of the system-under-test architecture, and minimize that system's servicing burden.

**Common core software support package.** The system should provide a large share of commonly used display and driver functions for digital flight systems, including (a) number conversion to any desired format and engineering units calibration, (b) bit unpacking and display as event, (c) snapshot block data, (d) parameter trace, (e) data recording or plotting as stripchart or X-Y parameters, and (f) waveform drivers for redundant flight control sensors.

**User-oriented displays.** The displays should have dynamically refreshed display and provide for user formatting and labeling. Free-form display formats should be available that can be easily constructed in real time (during a test procedure) as new requirements develop. The operator should have the ability to interrupt a display at any time, make modifications to the format, and resume the display within a few seconds. In addition, the operator should have the ability to make display hard copies at any time. Such hard copies should be labeled with date, time, test title, and any other user-determined information.

Utilization of commercial components. Where possible, the system should use commercially available card-level microcomputer hardware and commercial software. This enhances long-term maintenance and minimizes development costs.

Speed. The system should be able to service flight control systems with cycle rates on the order of 50 to 100 samples per second.

Synchronization. The system should acquire and display snapshots of several data words occurring within one computer cycle frame (10 to 20 milliseconds).

Maintenance. The system should contain an integral diagnostic and maintenance support capability.

Operational modes. The system should be easily and quickly convertible between the operating modes shown in figure 1, including real-time data display, open-loop function generator, redundant sensor simulator, and simple closed-loop simulation (a simulation at a single flight condition with linear equations of motion).

## FUNCTIONAL DESCRIPTION

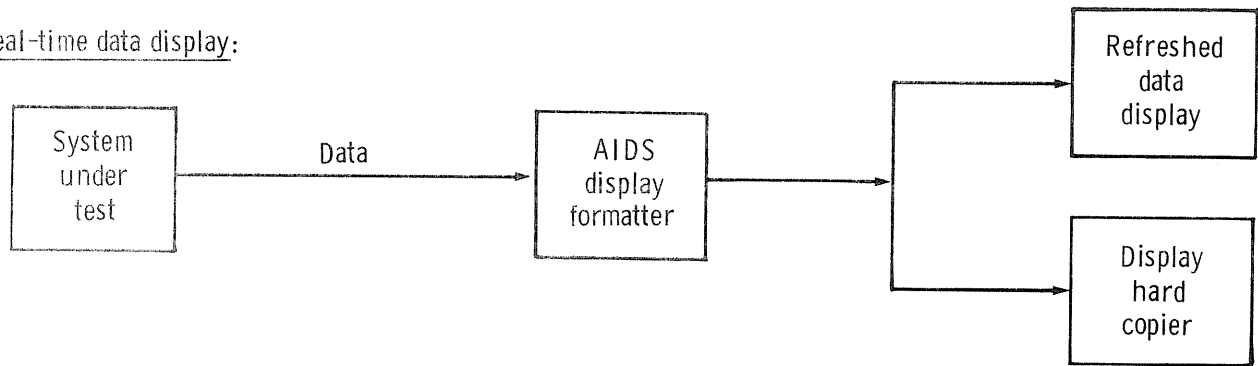
The first AIDS device that was developed generally met the design objectives. The AIDS was designed around an 8085A microprocessor system. A diskette subsystem was incorporated which was fully compatible with the off-line support software used to create the AIDS software load modules. A commercially available real-time multitasking executive (RTMTX) was also incorporated, mainly for the management of the diskette drives and diskette directory services.

Figure 2 illustrates the functional arrangement of the AIDS. The particular operating mode is defined by the software modules contained on the system diskette. Any user displays that were previously created are stored on the scratch diskette. These two diskettes are accessed via the real-time multitasking executive software that is permanently recorded on programmable read-only memory (PROM) integrated circuits. The remaining system software is loaded from the system diskette by the RTMTX, and the display formats are loaded from the scratch diskette by the RTMTX as needed. The RTMTX then transfers control of the system to the software loaded, but remains available for subsequent diskette operations and other multitasking as required.

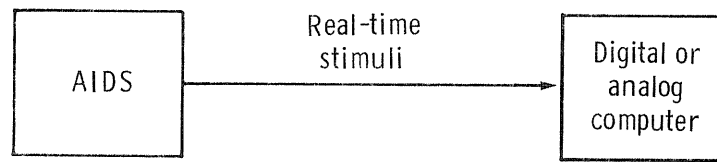
The AIDS supervisor module and companion operator input/output (I/O) modules are software that is common to all users. The supervisor provides command interpreting, software linking, a date register, an updated time-of-day register, and various system control functions. The I/O package provides the main operator interfaces to the control keyboard, the cathode ray tube (CRT) data display, and the hard copy peripherals. The operator enters system commands and display setup instructions via the control keyboard (KB). All displays are presented on the CRT display, which is refreshed at high speed on those areas of the screen which contain active (nonstatic) fields. Hard copies of any display may be made either by operator command or under supervisor control as desired.

User-unique software includes the user application supervisor, user timing control, and one or more user I/O modules. The user application supervisor provides servicing for user interrupts and interfaces with the RTMTX as required. The user timing control module provides basic timing for all user I/O and supporting computation. The user I/O servicing module services the data path to and from the system under test and provides for auxiliary analog outputs to nonAIDS peripheral devices as required.

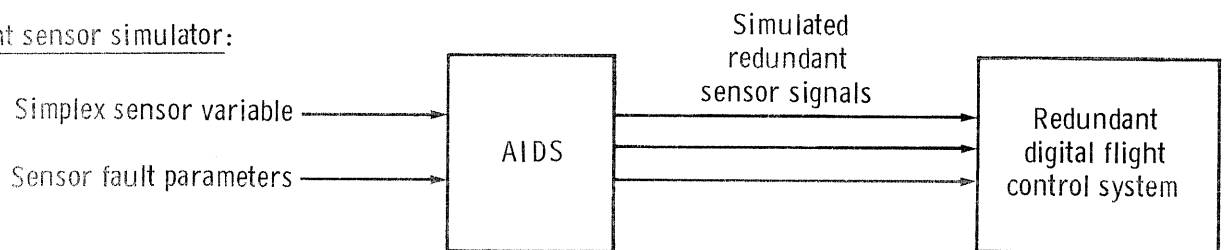
Real-time data display:



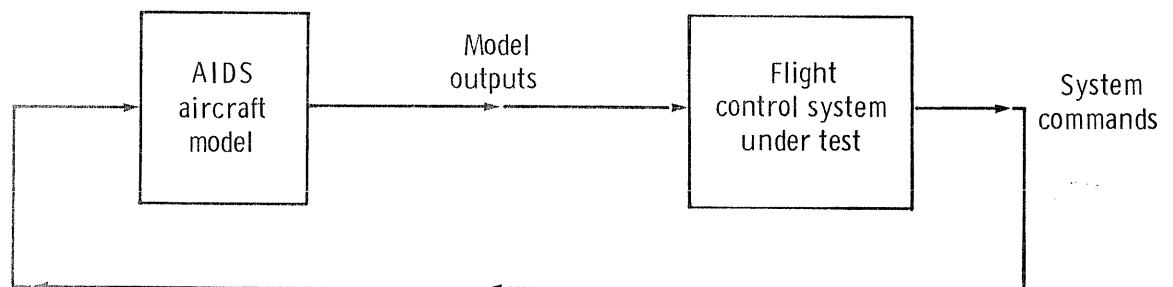
Open-loop function generator:



Redundant sensor simulator:



Closed-loop simulation:



*Figure 1. Examples of conceptual AIDS applications.*

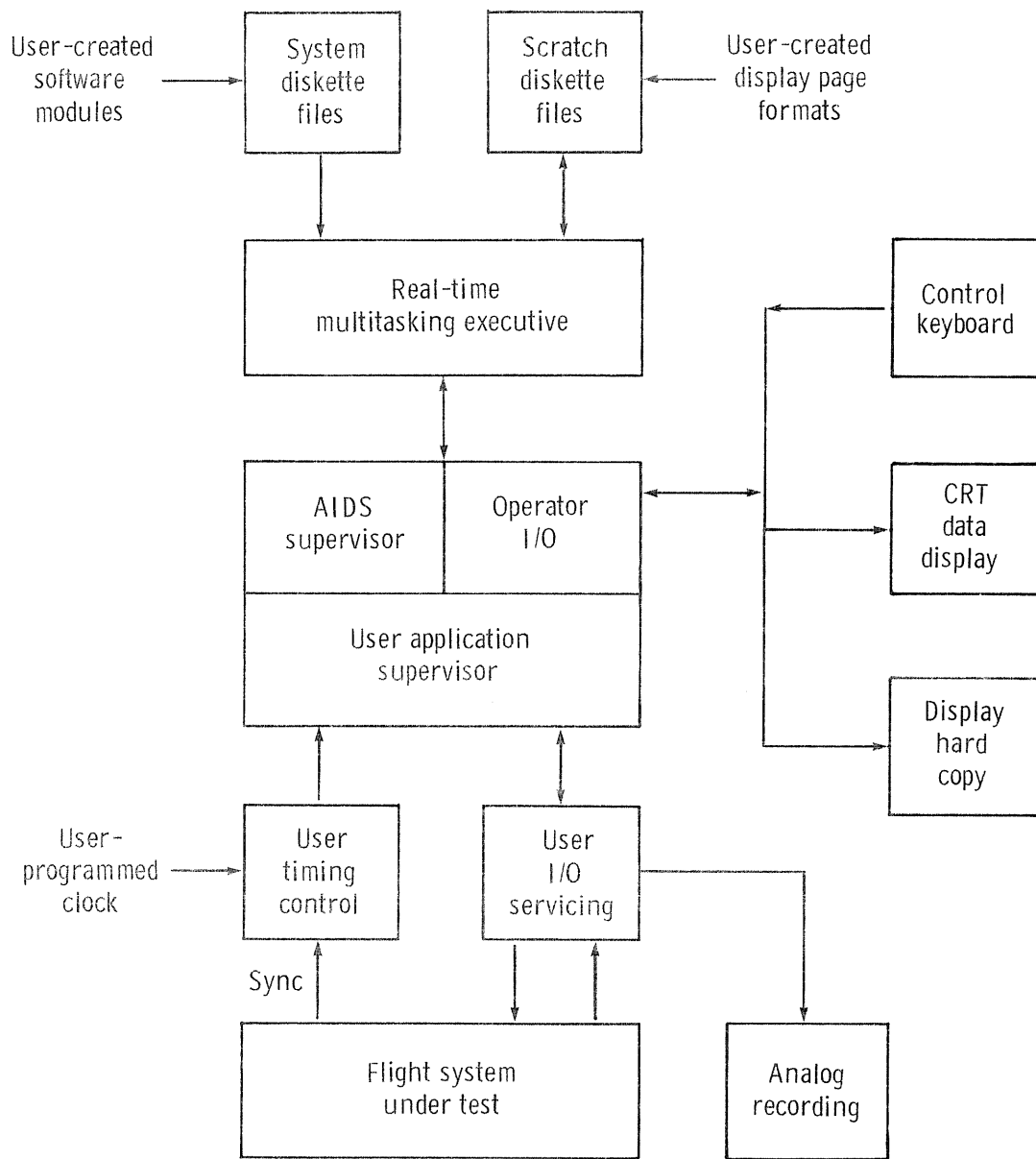


Figure 2. AIDS functional overview.



## HARDWARE DESCRIPTION

Figure 3 shows the mechanization of the current AIDS design. The entire system is mounted in a two-bay console that is mounted on wheels for mobility. The five major components are the computing subsystem, the I/O panel, the diskette drive subsystem, the operator terminal, and the line printer. The user must supply the appropriate cable(s) to mate the system under test to the I/O panel.

Appendix A contains a bill of materials for the major components of the present AIDS mechanization. The fabrication of the computing subsystem was quickly achieved using an industrial chassis incorporating a 12-slot card cage and integral power supply. Minor modifications to the chassis control panel were required to provide for a PROM set select switch, a bus timeout monitor indicator, and several test points. These additions are interfaced to the computing subsystem via circuitry on the universal prototype board.

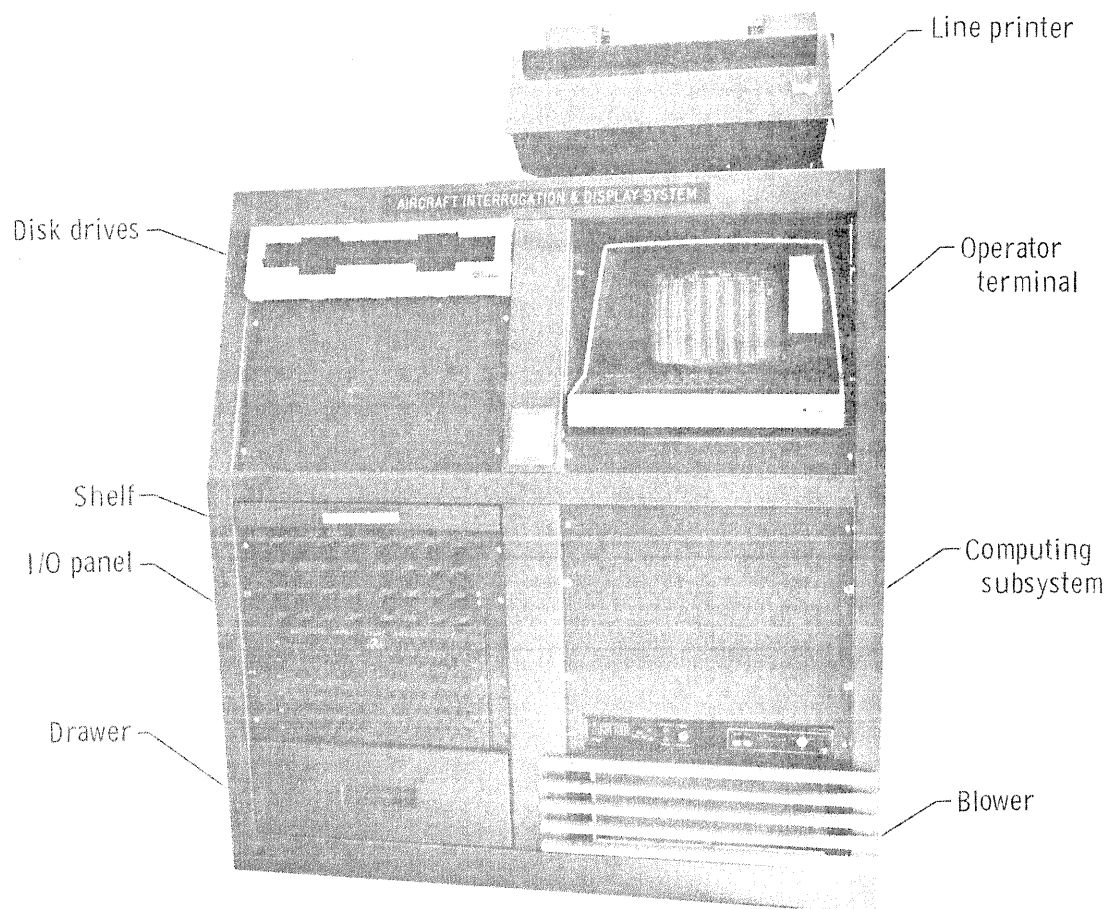
The various computing subsystem boards listed in appendix A are I/O mapped as shown in figure 4 and memory mapped as shown in figure 5. The central processor unit (CPU) board contains an 8085A microprocessor, which provides adequate computational capability for currently planned operating modes. Table 1 shows the assignment of system interrupts.

The floppy diskette drive unit is a dual-drive single density standard sized diskette system. It interfaces directly to the floppy diskette controller board in the computing subsystem. The single density format provides more than ample storage capability. One drive is used for system program modules, and the other is used for scratch file storage.

The operator terminal is a single unit with a full sized black and white CRT screen and full keyboard. The CRT and keyboard are interfaced to the computing subsystem via a full duplex serial port on system expansion board A. High speed refresh of the CRT display is performed in vectored cursor mode at 1920 characters per second. A minor terminal modification was necessary to provide software control over the cursor marker on the screen. This was achieved by rewiring the keyboard enable/disable flip-flop, which is under software control, to the cursor blanking circuit. This allows the cursor to be blanked during screen refresh operations, resulting in a flicker-free display. The keyboard has been wired permanently enabled.

The line printer is a 5 by 7 dot matrix printer with a dual channel vertical forms unit that allows the proper pagination of all system printouts. The interface to the computing subsystem is via a parallel discretes port on the central processor board.

The I/O panel is a NASA-designed and -constructed unit which provides the user an interface with the computing subsystem for analog and discrete signals. Figure 6 shows the signal paths within the I/O panel. The connectors for the user interface cable(s) are located on the rear of the AIDS cabinet. For each discrete, monitoring jacks and light-emitting diode (LED) indicator lamps are provided on the front of the I/O panel. Internal to the I/O panel are line drivers and receivers for the discretes, which provide the user with a balanced differential double-rail interface. The receivers interface to the computing subsystem via system expansion board A, and the drivers interface via system expansion board B. With regard to analog trunks, the I/O panel is passive and provides only break-out jacks on the front panel. The analog inputs interface with the computing subsystem via the analog input board, which scans the inputs using a  $\pm 10$  volt balanced multiplexer. The  $\pm 10$  volt unbalanced analog outputs from the computing subsystem are fed from the four analog output boards.



ECN 16415

*Figure 3. Aircraft interrogation and display system.*

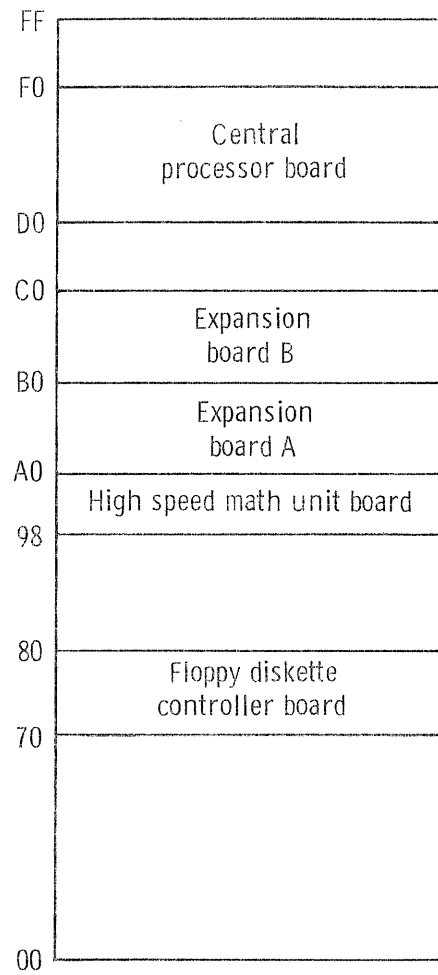


Figure 4. AIDS I/O address map.

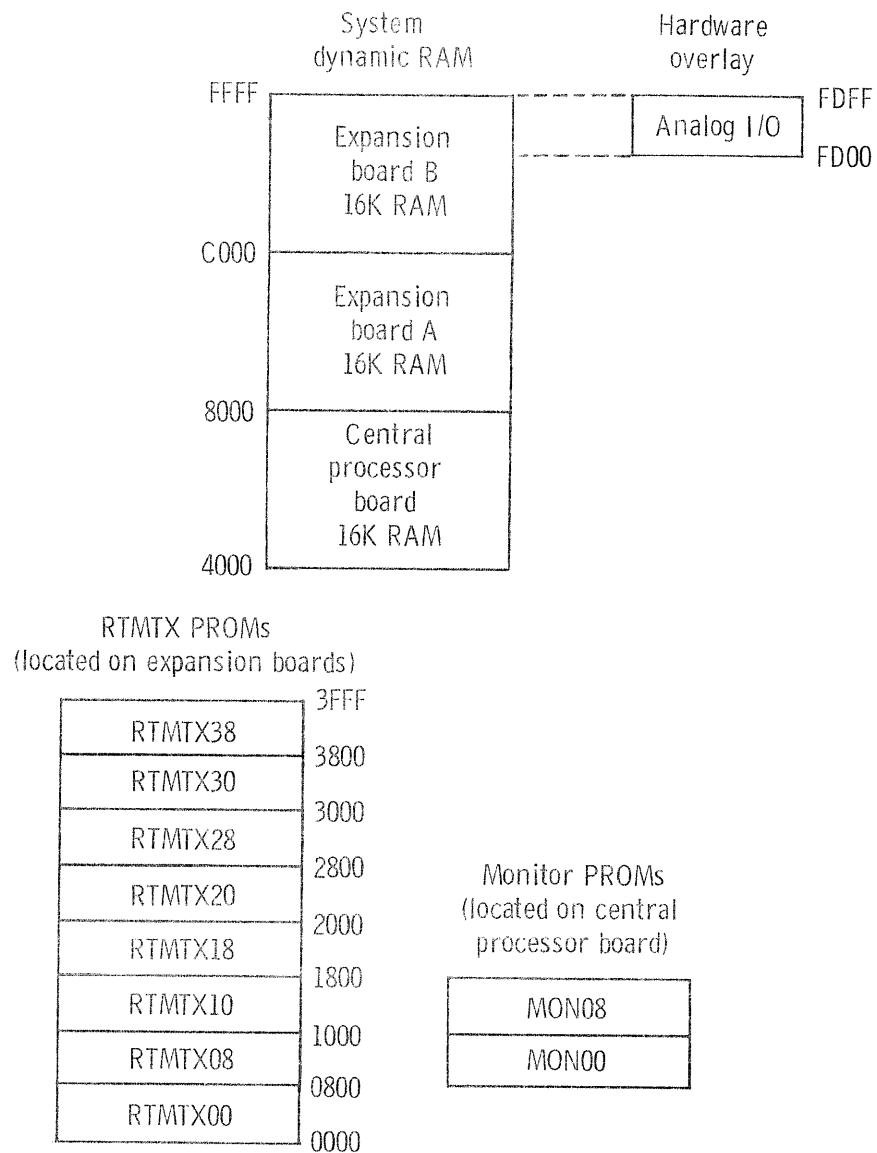


Figure 5. AIDS memory map.

TABLE 1.—AIDS INTERRUPT ALLOCATION

Level	Assignment	Application
Trap	Not used	-----
A	Bus timeout	AIDS tally only
B	Not used	-----
C	Not used	-----
0	INTR pushbutton	User manual interrupt
1	Timer no. 0	RTMTX task wait timer
2	Disk controller	RTMTX diskette I/O
3	Timer no. 1	User clock
4	External interrupt	User sync
5	1 Hz interrupt	AIDS time of day clock
6	USART C receiver	RTMTX terminal handler
7	USART C transmitter	RTMTX terminal handler

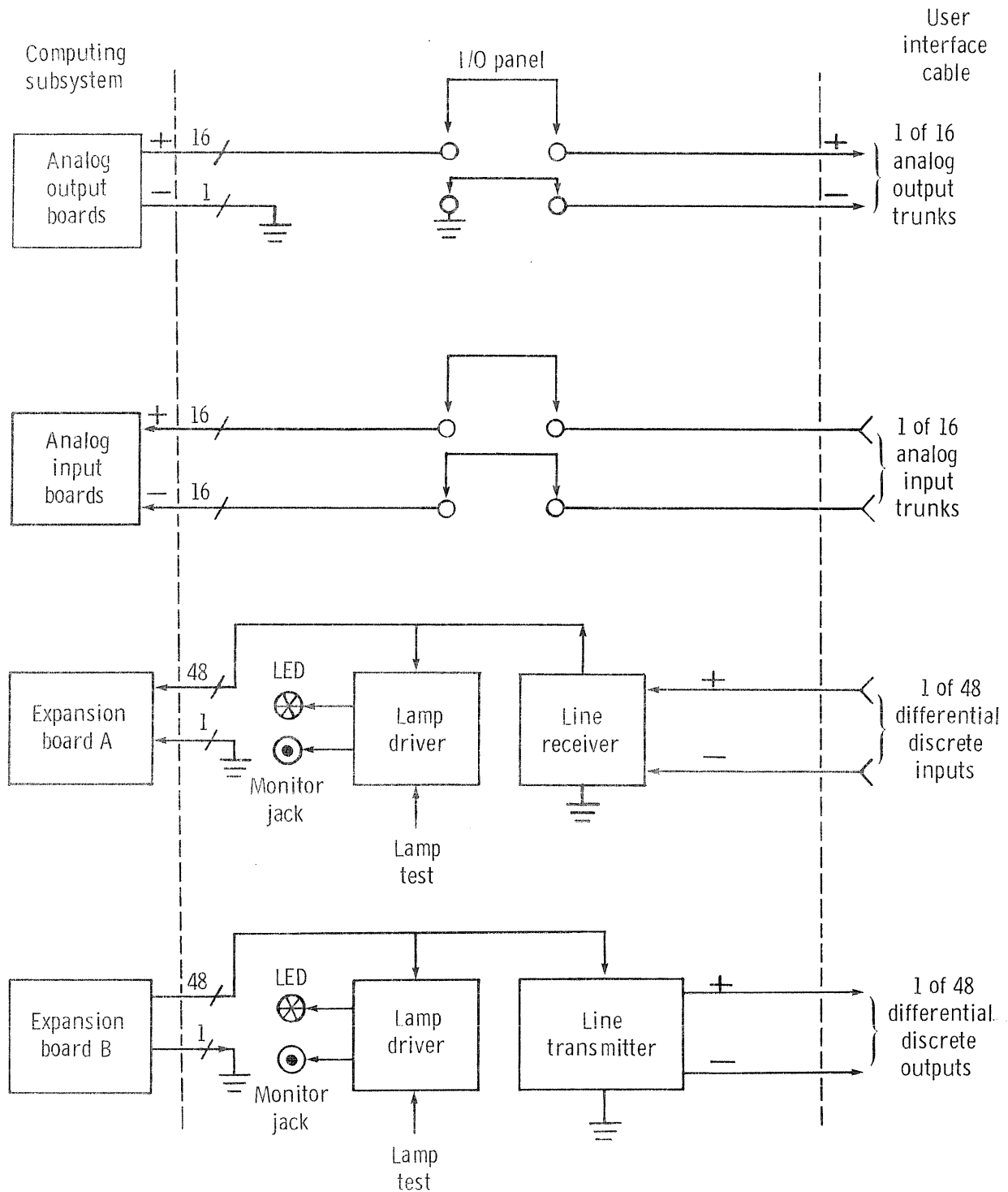


Figure 6. AIDS I/O paths.

## SOFTWARE DESIGN

Two separate software systems are resident within the AIDS. They are alternately accessible to the operator via a PROM select switch on the front of the computing subsystem chassis. One system is the maintenance and diagnostic software system, which consists of a commercial monitor package designed for the central processor board plus a NASA-designed set of extension routines. This package, which is stored as firmware on two PROMs that are installed on the central processor board, is executed when the PROM select switch is in the "monitor" position. This software provides basic AIDS troubleshooting services and diskette subsystem test routines.

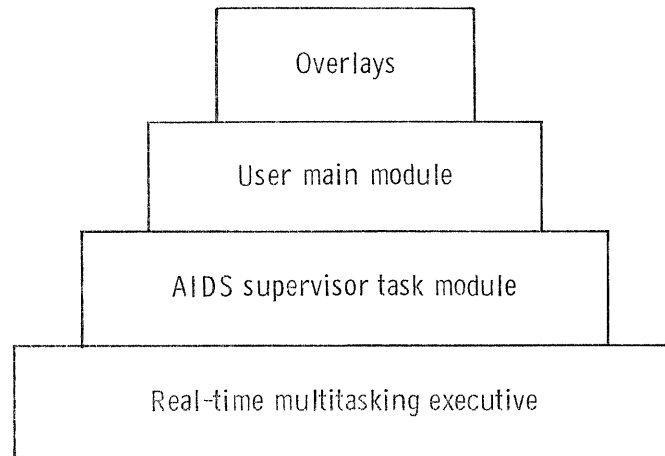
The second software system is the main AIDS hierarchy, which consists of the components shown in figure 7. This software structure is shown from bottom to top in the order the four components become active in the system. The first component to execute is the RTMTX, which is a commercial package designed to be used with the central processor board and provides diskette subsystem services. This package is stored as firmware on eight PROMs installed on the system expansion boards and is executed when the PROM select switch is in the "disk" position. The remaining three software components are loaded into the AIDS memory from the system diskette in drive 0, and are mapped as shown in figure 8.

Embedded in the RTMTX firmware is a configuration module that defines the characteristics and mapping of the diskette subsystem hardware. It also specifies the tasks to be created when the system is initialized. The task list includes the diskette drive controller board handler, the diskette I/O handler, several diskette directory servicing routines, the full terminal handler, and the bootstrap loader. These routines and associated variables are accessible via PUBLIC labels, which can be linked to user code. Since the RTMTX code requires no maintenance, the PROM set never requires reprogramming and the integrity of the hardware is enhanced. Appendix B contains a listing of the configuration module and the SUBMIT file used to create the RTMTX firmware.

When the AIDS is powered up (or reset) with the PROM select switch in the "disk" position, the RTMTX begins executing and sets up the tasks specified by the configuration module. When the bootstrap loader becomes the active task, it seeks a file called RMXSYS on the system diskette, loads it into random access memory, and starts executing it. The file :F0:RMXSYS always contains the AIDS supervisor task module component of the AIDS software hierarchy. Once loaded, this module assumes central control of the system and is the point to which all other components return when execution is completed.

The AIDS supervisor contains an initialization routine followed by a looping command interpreter routine. It also contains many routines which are commonly needed by the different AIDS users. These include the CRT/KB handler, printer handler, analog I/O drivers, scratch diskette librarian, time-of-day clock, display data formatters, and utility routines. These can be accessed by a user via hard-mapped linkages in the common data area.

One of the functions performed by the AIDS supervisor during the initialization procedure is to request the RTMTX to load a module called USER from the system diskette. The file :F0:USER always contains the user main module component of the software hierarchy. Within it are contained the user interrupt servicing routines, user I/O packages, and an initialization subroutine. It also contains tables defining the syntax for user commands and user scratch file load control.



*Figure 7. AIDS software hierarchy.*



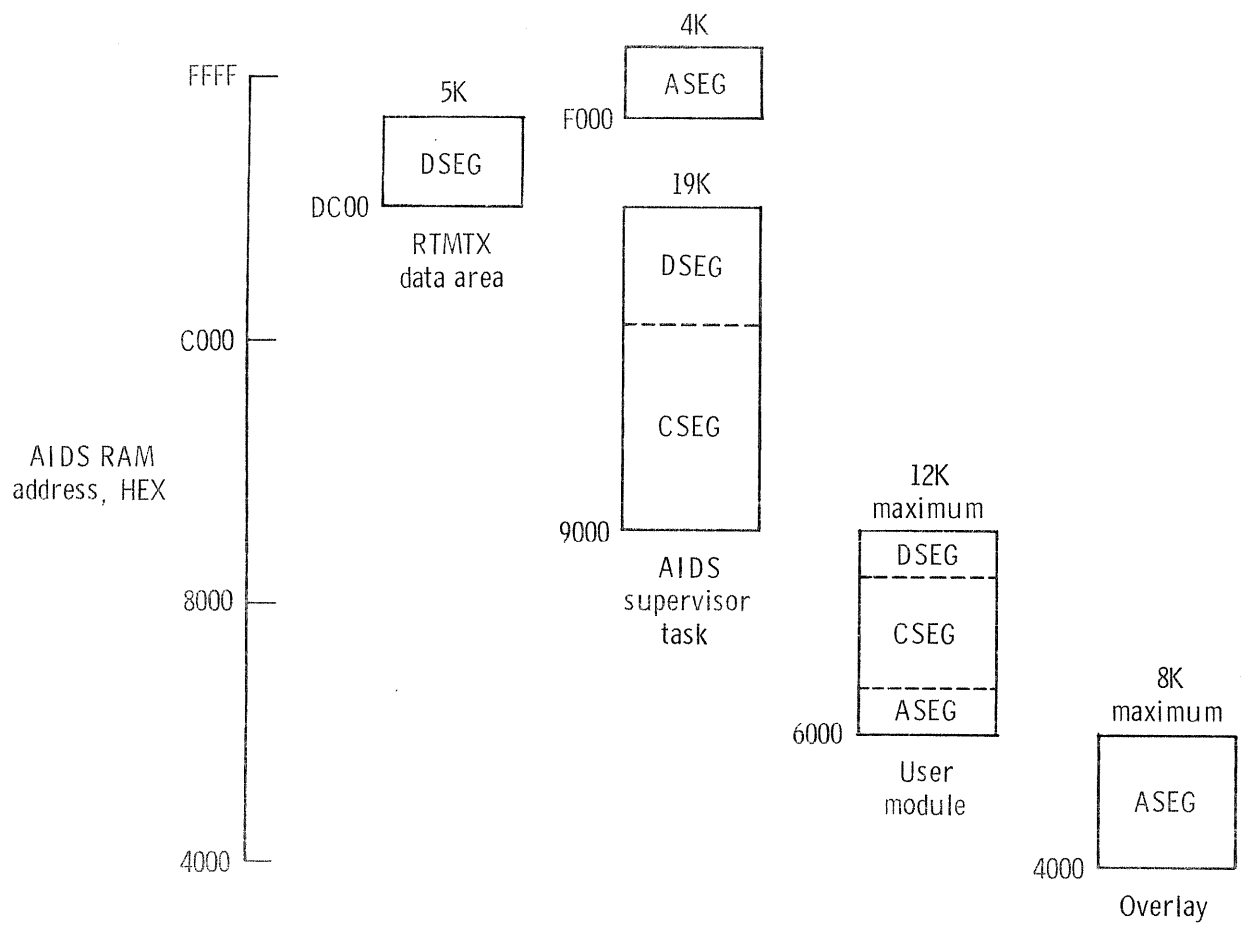


Figure 8. AIDS RAM allocation.

The fourth component of the AIDS software hierarchy are overlays. Overlay modules are generally loaded and executed in response to a keyboard command, and they always provide a specific function. They are linked to the remaining software via absolute entry addresses within the overlay area and, like the USER main module, have access to AIDS supervisor subroutines and variables via the common area. In general, each overlay has associated with it a unique display which is presented on the CRT. Overlays may be either system or user related. Most are operator interactive, and all must exit back to the AIDS supervisor when the KB escape key is pressed. System overlays provide functions such as interrupt control, printer moding, clock management, and I/O panel monitoring. User overlays are not restricted as to function but must conform to the mapping, linkage, and escape conventions required of all AIDS overlays.

Taken as a whole, the design of the AIDS software is intended to provide a multitasking environment within which the various system and user tasks can share a single CPU. The lowest priority task is always the servicing of the operator interface, which includes the CRT, KB, and printer. All higher priority tasks are invoked by interrupts, which require temporarily halting the operator I/O. A typical user application might involve responding to a sync interrupt from the system under test, inputting data, performing computations, outputting data, and setting up a data buffer for the current operator display. As the amount of time required to service such an interrupt increases, the most noticeable effect is the slowing of CRT screen refresh. Another variable that affects screen refresh is the amount of data being displayed, since there is computational overhead associated with formatting as well as screen write operations. The performance of the AIDS in various applications will be later quantified as a duty cycle or percentage of time which is devoted to interrupt-driven code execution as opposed to operator I/O.

## USER EXPERIENCE

Since 1978, the AIDS has been employed in support of three research projects and is planned for use in at least two others. Two AIDS units are in active use, and a third unit is soon to enter service. The F-8 DFBW iron bird application (ref. 1) allows closed-loop aerodynamic simulation and redundant sensor fault emulation, providing valuable support in software verification and validation. The HiMAT remotely piloted research vehicle application (ref. 2) provides open-loop display of onboard computer memory data. It is used extensively in support of simulation, preflight testing, and system troubleshooting. Another user project is an experimental nodal network data bus breadboard (ref. 3). For this project the AIDS provides test set capability for the I/O processor in each node and monitors bus message traffic. A planned future application is support for the AFTI/F-111 project (ref. 4) where the AIDS will monitor the interchannel message traffic within the redundant flight system. Another future application is support for the DAST ARW-II project (ref. 5), where the AIDS will provide test set capability for a multiprocessor flight computer as well as provide the usual data display functions.

One measure of the performance of the AIDS is the loading or level of saturation of its central processor for each application. Loading may be defined as the duty cycle or percentage of time required to perform time-critical (interrupt-linked) computational tasks as opposed to operator I/O functions. The duty cycle ranges from 90 percent for the F-8 DFBW simulation to 10 percent for the HiMAT data display function. Screen refresh rates for the F-8 DFBW are very low (typically 0.5 per second). For a typical HiMAT display, however, the refresh rate is comfortably high (4 per second). The time required to perform a line printer hard copy of a display snapshot is roughly proportional to the refresh rate of the display and varies from 20 seconds to 5 seconds.

The HiMAT application best demonstrates the capabilities of the AIDS, and it has accumulated the most AIDS operating time, with over 2000 hours in a 3 year period. This application grew out of the need to augment the data display capability of the manufacturer-supplied GSE, called the system test console (STC). The STC mates with the HiMAT aircraft umbilical connector, and one of its functions is to allow the contents of the onboard computer memory to be examined. However, the STC can only display a single byte as a bit pattern expressed in octal digits, severely limiting the visibility of the functioning of the onboard computer.

To provide the needed additional display capability, the AIDS was connected to the STC as shown in figure 9. The 16 address lines are tied in common to the STC thumb-wheels used for manual RAM address selection. The 8 data lines are tied to the output from the onboard computer, which feeds the decoders driving the STC octal display. The AIDS sequentially outputs an address, waits for a sync pulse from the onboard computer, and then reads the RAM data byte output by the computer. This sequence is repeated every 20 milliseconds, which is the rate at which the onboard program services the test console interface.

The AIDS operator controls which addresses are to be read by creating with KB inputs a formatted CRT display (called a page) that specifies by data type and RAM memory location, which items are desired. Table 2 shows the different data display formats available to the operator. Of these, only codes VG and DG (specially scaled fixed-point formats for the vertical gyro and directional gyro, respectively) are unique to HiMAT. Note that a single data item causes from 1 to 15 successive RAM addresses to be read. The AIDS software builds an address table based on the display requirements and scans this table repetitively. As the data is returned, it is buffered, formatted for display, and presented on the CRT in a continuously refreshed mode.

Appendix C contains hard copies of representative HiMAT displays. Also shown is a typical scratch diskette directory page and a hard copy of the command interpreter display, which lists the system and user commands available. The HiMAT project uses these display pages and others to support software verification and validation, system maintenance, preflight and postflight tests, and closed-loop simulations. Over 100 display page formats of various types have been created and placed on scratch diskette. The AIDS has become an integral part of such critical testing as the preflight test, where AIDS data dumps are written into several procedure sequences. The ability to select a scratch diskette and quickly (in 1 to 3 seconds) load any of up to 45 display page files has been of great benefit to the HiMAT project. In addition, the inherent flexibility of the software system has been demonstrated repeatedly by the changes that have easily been implemented in response to project engineering request.

## CONCLUDING REMARKS

General purpose user-programmable ground support equipment has been developed and placed in service in support of both aircraft and simulation facilities. Three years' experience involving several users has demonstrated the utility of the system concept and created a demand for additional systems to support future users. The flexibility of the concept has been demonstrated in a wide range of applications, including real-time data acquisition, software verification and validation, system integration testing, and real-time closed-loop simulation.

The major contribution of the system, known as the aircraft interrogation and display system (AIDS), has been its ability to make visible the functioning of a digital flight

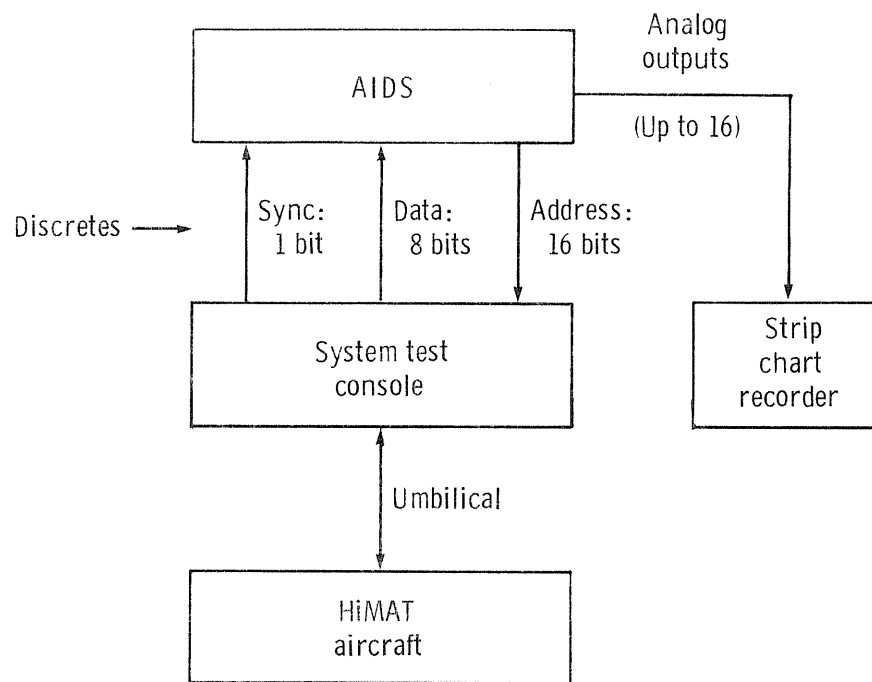


Figure 9. AIDS to HiMAT interface.

TABLE 2. - AIDS DATA DISPLAY FORMATS

Number	Code	Number of bytes	Number of bits	Data type	Sign?	Number of columns	Display format
1	H1	1	8	Any	---	2	HH
2	H2	2	16	Any	---	4	HHHH
3	H3	3	24	Any	---	6	HHHHHH
4	H4	4	32	Any	---	8	HHHHHHHH
5	B1	1	8	Any	---	8	BBBBBBBB
6	B2	2	16	Any	---	16	BBBBBBBBBBBBBBBB
7	F4	4	32	Floating point	Y	10	[ - ]DDDDD.DDD
8	I1	1	8	Integer	N	4	DDD
9	I2	2	16	Integer	N	6	DDDDD
10	D1	1	8	Integer	Y	4	[ - ]DDD
11	D2	2	16	Integer	Y	6	[ - ]DDDDD
12	DD	2	12	DAC value	Y	6	[ - ]DDDDD
13	DH	2	12	DAC value	---	3	HHH
14	DV	2	12	DAC value	Y	7	[ - ]DD.DDD
15	O1	1	8	Any	---	3	OOO
16	O2	2	16	Any	---	6	OOOOOO
17	A1	1	---	ASCII string	---	1	A
18	A2	2	---	ASCII string	---	2	AA
19	A3	3	---	ASCII string	---	3	AAA
20	A4	4	---	ASCII string	---	4	AAAA
21	A5	5	---	ASCII string	---	5	AAAAA
22	A6	6	---	ASCII string	---	6	AAAAAA
23	A7	7	---	ASCII string	---	7	AAAAAAA
24	A8	8	---	ASCII string	---	8	AAAAAAAA
25	A9	9	---	ASCII string	---	9	AAAAAAAAA
26	AA	10	---	ASCII string	---	10	AAAAAAAAAA
27	AB	11	---	ASCII string	---	11	AAAAAAAAAAA
28	AC	12	---	ASCII string	---	12	AAAAAAAAAAAA
29	AD	13	---	ASCII string	---	13	AAAAAAAAAAAAA
30	AE	14	---	ASCII string	---	14	AAAAAAAAAAAAAA
31	AF	15	---	ASCII string	---	15	AAAAAAAAAAAAAAA
32	E0	1	1	Event bit 0	---	4	" ONE" or "ZERO"
33	E1	1	1	Event bit 1	---	4	" ONE" or "ZERO"
34	E2	1	1	Event bit 2	---	4	" ONE" or "ZERO"
35	E3	1	1	Event bit 3	---	4	" ONE" or "ZERO"
36	E4	1	1	Event bit 4	---	4	" ONE" or "ZERO"
37	E5	1	1	Event bit 5	---	4	" ONE" or "ZERO"
38	E6	1	1	Event bit 6	---	4	" ONE" or "ZERO"
39	E7	1	1	Event bit 7	---	4	" ONE" or "ZERO"
40	F1	1	8	Fixed point	Y	10	[ - ]DDDDD.DDD
41	F2	2	16	Fixed point	Y	10	[ - ]DDDDD.DDD
42	DG	2	16	Directional gyro	Y	10	[ - ]DDD.DDD
43	VG	2	16	Vertical gyro	Y	10	[ - ]DDD.DDD

Display format key: H = hexadecimal digit 0 to 9, A to F

B = binary digit 0 or 1

D = decimal digit 0 to 9

O = octal digit 0 to 7

A = any ASCII character

system, thus enhancing test coverage, troubleshooting, and the efficiency with which experiments are conducted.

The use of off-the-shelf commercial hardware and operating system software greatly reduced the development effort and cost of ownership.

Because of the capabilities of AIDS and its user-oriented operational features, experience to date, which has involved a complex flight development and integration project, has been excellent, with extremely high acceptance.

*National Aeronautics and Space Administration  
Ames Research Center  
Dryden Flight Research Facility  
February 3, 1982*

## APPENDIX A.—AIDS COMPONENTS

This appendix lists the components of AIDS.

The major computing subsystem components, which are from the Intel Corporation, are as follows:

ICS-80 KIT 640 Chassis and Power Supply (1 each)

Rack mount chassis, control panel, heavy duty power supply, four-slot card cage module, multibus backplane

SBC 614 Card Cage Modules (2 each)

Expands above kit to 12 slots capacity

SBC 80/30 Central Processor Board (1 each)

8085A CPU, 16K bytes RAM, 4K bytes PROM, serial port, 24 discrete I/O lines, interval timer, interrupt controller

SBC 116 Expansion Boards (2 each)

16K bytes RAM, 8K bytes PROM, 48 discretized I/O, serial port

SBC 724 Analog Output Boards (4 each)

Each board provides four 12-bit DAC channels, range  $\pm 10$  volts

SBC 711 Analog Input Board (1 each)

Provides 16 balanced channels, range  $\pm 10$  volts, 12-bit A/D

SBC 204 Floppy Diskette Controller Board (1 each)

Provides control of two single-density standard sized drives

SBC 310 High Speed Math Unit Board (1 each)

Provides 16-bit and 32-bit arithmetic, fixed and floating point

SBC 905 Universal Prototype Board (1 each)

1 Hz clock circuitry, bus timeout monitor circuit, PROM switching control logic, external interrupt termination

RMX80 Real-Time Multitasking Executive (1 each)

RMX830.LIB, BOT830.LIB, BOTUNR.LIB, DFSDIR.LIB, DIO830.LIB, DFSUNR.LIB, THI830.LIB, THO830.LIB, PLM80.LIB

Additional components of the AIDS are as follows:

#### Floppy Diskette Drive Unit

Manufacturer: Data Systems Design, Inc.

Type: DSD-110-IN-2A drive unit (1 each)

DSD-CM chassis mount for rack (1 each)

Interface: Cable provided to mate with SBC-204 controller

Characteristics: Dual drives, standard sized floppy diskettes, single density  
IBM soft-sectored

#### Operator Terminal

Manufacturer: SOROC Technology

Type: IQ-120

Interface: RS-232C serial

Characteristics: 19,200 baud rate, 24 lines by 80 columns, vectored cursor capability



#### Line Printer

Manufacturer: Centronics Data Computer Corp.  
Type: 306C  
Interface: Standard Centronics parallel TTL interface  
Characteristics: 5 × 7 dot matrix, tractor feed, 80/132 character/line,  
120 character/second print rate, two-channel vertical forms unit

## APPENDIX B.—AIDS REAL-TIME MULTITASKING EXECUTIVE LISTINGS

Following are printer listings generated during the building of the AIDS real-time multitasking executive firmware.

## Configuration Module

This listing shows the software components which together comprise the software system create table. It defines the initial task table, the initial exchange table, several hardware definition tables, and miscellaneous data storage area declarations.

ASM80 :F1:CONFIG

ISIS-II 8080/8085 MACRO ASSEMBLER, V3.0      CONFIG    PAGE    1  
AIDS RMX SYSTEM CONFIGURATION MODULE    12 DEC 1979

LOC	OBJ	LINE	SOURCE STATEMENT
		1 \$	TITLE('AIDS RMX SYSTEM CONFIGURATION MODULE    12 DEC 1979')
		2	
		3	NAME    CONFIG                    ; R GLOVER
		4	PUBLIC   RQCRTB
		5	PUBLIC   RQL0EX,RQL3EX,RQL4EX,RQL5EX,RQLAEX,RQLBEX,RQLCEX
		6	
		7	CSEG
		8	
0000	0600	C    9	RQCRTB: DW    ITT                    ; INITIAL TASK TABLE
0002	0A	10	DB    10
0003	0000	C    11	DW    IET                    ; INITIAL EXCHANGE TABLE
0005	12	12	DB    18
		13	
		14	ITT:
		15	
		16 ;	DISK CONTROLLER TASK
		17	
		18	PUBLIC   RQL2EX,CNTL1X
		19	EXTRN   RQHD4
		20	
0006	53424332	21	TASK1: DB    'SBC204'            ; DISK CONTROLLER BOARD HANDLER
000A	3034		
000C	0000	E    22	DW    RQHD4
000E	9600	D    23	DW    STK1
0010	5000	24	DW    B0
0012	21	25	DB    33                    ; INTERRUPT LEVEL 2 USED FOR 204 BOARD
0013	7800	D    26	DW    CNTL1X
0015	EA02	D    27	DW    TD1
		28	
		29 ;	TERMINAL HANDLER TASK
		30	
		31	PUBLIC   RREADX,WRITX
		32	EXTRN   RQTHDI,RQINPX,RQOUTX,RQWAKE,RQDBUG,RQALRM,RQL6EX,RQL7EX
		33	
0017	5445524D	34	TASK2: DB    'TERMIO'
001B	494F		
001D	0000	E    35	DW    RQTHDI
001F	E600	D    36	DW    STK2
0021	2400	37	DW    36
0023	70	38	DB    112                    ; INTERRUPT LEVEL 6 USED FOR KEYBOARD INPUT
0024	0000	E    39	DW    RQOUTX
0026	FE02	D    40	DW    TD2
		41	
		42 ;	DISK I/O MAIN TASK
		43	
		44	EXTRN   RQPDsk,RQDSKX
		45	
002B	4449534B	46	TASK3: DB    'DISKIO'
002C	494F		
002E	0000	E    47	DW    RQPDsk
0030	0A01	D    48	DW    STK3
0032	3000	49	DW    48
0034	81	50	DB    129
0035	0000	E    51	DW    RQDSKX

LOC	OBJ	LINE	SOURCE STATEMENT
0037	1203	D 52	DW TB3
		53	
		54 ;	DISK SERVICES TASKS (6)
		55	
		56	PUBLIC RQDBUF,RQBAB
		57	EXTRN RQPDIR,RQPATR,RQDEL,RQFMT,RQPLD,RQPRNM
		58	EXTRN RQDIRX,RQATRX,RQDELX,RQFMTX,RQLDX,RQRNMX
		59	
0039	44495253	60 TASK4: DB	'DIRSVC' ; DIRECTORY SERVICES
003D	5643		
003F	0000	E 61	DW RQPDIR
0041	3A01	D 62	DW STK4
0043	3000	63	DW 48
0045	82	64	DB 130
0046	0000	E 65	DW RQDIRX
0048	2603	D 66	DW TB4
		67	
004A	41545452	68 TASK5: DB	'ATTRIB' ; ATTRIBUTES
004E	4942		
0050	0000	E 69	DW RQPATR
0052	6A01	D 70	DW STK5
0054	4000	71	DW 64
0056	83	72	DB 131
0057	0000	E 73	DW RQATRX
0059	3A03	D 74	DW TDS
		75	
005B	44454C45	76 TASK6: DB	'DELETE'
005F	5445		
0061	0000	E 77	DW RQDEL
0063	AA01	D 78	DW STK6
0065	4000	79	DW 64
0067	84	80	DB 132
0068	0000	E 81	DW RQDELX
006A	4E03	D 82	DW TB6
		83	
006C	464F524D	84 TASK7: DB	'FORMAT'
0070	4154		
0072	0000	E 85	DW RQFMT
0074	EA01	D 86	DW STK7
0076	4000	87	DW 64
0078	85	88	DB 133
0079	0000	E 89	DW RQFMTX
007B	6203	D 90	DW TB7
		91	
007D	4C4F4144	92 TASK8: DB	'LOAD '
0081	2020		
0083	0000	E 93	DW RQPLD
0085	2A02	D 94	DW STK8
0087	4000	95	DW 64
0089	86	96	DB 134
008A	0000	E 97	DW RQLDX
008C	7603	D 98	DW TB8
		99	
008E	52454E41	100 TASK9: DB	'RENAME'
0092	4045		

LOC	OBJ	LINE	SOURCE STATEMENT
0094	0000	E 101	DW RQPKMH
0096	6A02	D 102	DW STK9
0098	4000	103	DW 64
009A	87	104	DB 135
009B	0000	E 105	DW RQRNMH
009D	8A03	D 106	DW TD9
		107	
		108 ;	BOOTSTRAP LOADER TASK
		109	
		110	PUBLIC RQPOOL
		111	EXTRN RQBOOT
		112	
009F	424F4F54	113	TASK10: DB 'BOOT '
00A3	2020		
00A5	0000	E 114	DW RQBOOT
00A7	AA02	D 115	DW STK10
00A9	4000	116	DW 64
00AB	FE	117	DB 254
00AC	0000	118	DW 0
00AE	9E03	D 119	DW TD10
		120	
		121 ;	INITIAL EXCHANGE TABLE
		122	
00B0	0F00	D 123	IET: DW RQL2EX
00B2	7B00	D 124	DW CNTLIX
00B4	0000	E 125	DW RQINPX
00B6	0000	E 126	DW RQOUTX
00B8	0000	E 127	DW RQWAKE
00BA	0000	E 128	DW RQBBUG
00BC	0000	E 129	DW RQALRM
00BE	0000	E 130	DW RQL6EX
00C0	0000	E 131	DW RQL7EX
00C2	8200	D 132	DW UREADX
00C4	BC00	D 133	DW UWRITX
00C6	0000	E 134	DW RQDSKX
00C8	0000	E 135	DW RQDIRX
00CA	0000	E 136	DW RQATRX
00CC	0000	E 137	DW RQDELX
00CE	0000	E 138	DW RQFMTX
00D0	0000	E 139	DW RQLDX
00D2	0000	E 140	DW RQRNMH
		141	
		142 ;	TABLES FOR DISK CONTROLLER TASK
		143	
		144	PUBLIC RQCST,RQNDV,RQDCT,RQDRC4
		145	
00D4	02	146	RQCST: DB 2 ; CONTROLLER SPECIFICATION TABLE
00D5	70	147	DB 70H ; 204 BOARD I/O ADDRESS
00D6	02	148	DB 2 ; INTERRUPT LEVEL 2
00D7	0F00	D 149	DW RQL2EX
00D9	7B00	D 150	DW CNTLIX
		151	
00DB	02	152	RQNDV: DB 2 ; NUMBER OF DRIVES
		153	
00DC	4630	154	RQDCT: DB 'F0' ; DEVICE CONFIGURATION TABLE

LOC	OBJ	LINE	SOURCE STATEMENT	
00DE	00	155	DB	0,0,0
00DF	00			
00E0	00			
00E1	4631	156	DB	'F1'
00E3	00	157	DB	0,0,1
00E4	00			
00E5	01			
		158		
00E6	01	159	RDR4: DB	1 ; DRIVE CHARACTERISTICS TABLE
00E7	70	160	DB	70H ; 204 BOARD I/O ADDRESS
00E8	00	161	DB	0 ; CONTROLLER CHIP 0
00E9	08	162	DB	8 ; TRACK STEP TIME = 8 MS
00EA	08	163	DB	8 ; HEAD SETTLING TIME = 8 MS
00EB	49	164	DB	49H ; INDEX COUNT = 4 , LOAD TIME = 35 MS
		165		
		166	;	BUFFER ALLOCATION BLOCK
		167		
00EC	0000	168	ROBAD: DW	0,0 ; STATIC MODE
00EE	0000			
00F0	02	169	DB	2 ; MAXIMUM OF 2 FILES CONCURRENTLY OPEN
00F1	6E07	170	DW	DABRAM
		171		
		172	DSEG	
		173		
0000		174	RQL0EX: DS	15 ; EXCHANGE AREA
000F		175	RQL2EX: DS	15
001E		176	RQL3EX: DS	15
002D		177	RQL4EX: DS	15
003C		178	RQL5EX: DS	15
004B		179	RQLAEX: DS	15
005A		180	RQLBEX: DS	15
0069		181	RQLCEX: DS	15
0078		182	CNTLIX: DS	10
0082		183	UREADX: DS	10
008C		184	UNWRITX: DS	10
		185		
0096		186	STK1: DS	80 ; STACK AREA
00E6		187	STK2: DS	36
010A		188	STK3: DS	48
013A		189	STK4: DS	48
016A		190	STK5: DS	64
01AA		191	STK6: DS	64
01EA		192	STK7: DS	64
027A		193	STK8: DS	64
026A		194	STK9: DS	64
02AA		195	STK10: DS	64
		196		
02EA		197	TD1: DS	20 ; TASK DESCRIPTOR AREA
02FE		198	TD2: DS	20
0312		199	TD3: DS	20
0326		200	TD4: DS	20
033A		201	TD5: DS	20
034E		202	TD6: DS	20
0362		203	TD7: DS	20
0376		204	TD8: DS	20

LOC	OBJ	LINE	SOURCE STATEMENT
038A		205	TD9: DS 20
039E		206	TD10: DS 20
		207	
03B2		208	RQPOOL: DS 256 ; BOOTSTRAP LOADER BUFFER
04B2		209	RQDBUF: DS 700 ; DIRSVC BUFFER
076E		210	BABRAM: DS 800 ; BAB BUFFER
		211	
		212	END

PUBLIC SYMBOLS

CNTLIX D 0078	RQBAB C 00EC	RQCRTB C 0000	RQCST C 00D4	RQDBUF D 04B2	RQDCT C 00DC	RQDRC4 C 00E6
RQLOEX D 0000	RQL2EX D 000F	RQL3EX D 001E	RQL4EX D 002D	RQL5EX D 003C	RQLAEX D 004B	RQLBEX D 005A
RQLCEX D 0069	RQND4 C 00DB	RQPOOL D 03B2	UREADX D 00B2	UWRITX D 00BC		

EXTERNAL SYMBOLS

RQALRM E 0000	RQATRX E 0000	RQBOOT E 0000	RQDBUG E 0000	RQDELX E 0000	RQDIRX E 0000	RQDSKX E 0000
RQFMTX E 0000	RQHD4 E 0000	RQINPX E 0000	RQL6EX E 0000	RQL7EX E 0000	RQLDX E 0000	RQOUTX E 0000
RQFATR E 0000	RQPDEL E 0000	RQPDIR E 0000	RQPDSK E 0000	RQPFMT E 0000	RQPLD E 0000	RQPRNM E 0000
RQRNMX E 0000	RQTHDI E 0000	RQMAKE E 0000				

USER SYMBOLS

BABRAM D 076E	CNTLIX D 0078	IET C 00B0	ITT C 0006	RQALRM E 0000	RQATRX E 0000	RQBAB C 00EC
RQBOOT E 0000	RQCRTB C 0000	RQCST C 00D4	RQDBUF D 04B2	RQDBUG E 0000	RQDCT C 00DC	RQDELX E 0000
RQDIRX E 0000	RQDRC4 C 00E6	RQDSKX E 0000	RQFMTX E 0000	RQHD4 E 0000	RQINPX E 0000	RQLOEX D 0000
RQL2EX D 000F	RQL3EX D 001E	RQL4EX D 002D	RQL5EX D 003C	RQL6EX E 0000	RQL7EX E 0000	RQLAEX D 004B
RQLBEX D 005A	RQLCEX D 0069	RQLDX E 0000	RQND4 C 00DB	RQOUTX E 0000	RQFATR E 0000	RQPDEL E 0000
RQPDIR E 0000	RQPDSK E 0000	RQPFMT E 0000	RQPLD E 0000	RQPOOL D 03B2	RQPRNM E 0000	RQRNMX E 0000
RQTHDI E 0000	RQMAKE E 0000	STK1 D 0096	STK10 D 02AA	STK2 D 00E6	STK3 D 010A	STK4 D 013A
STK5 D 016A	STK6 D 01AA	STK7 D 01EA	STK8 D 022A	STK9 D 026A	TASK1 C 0006	TASK10 C 009F
TASK2 C 0017	TASK3 C 002B	TASK4 C 0039	TASK5 C 004A	TASK6 C 005B	TASK7 C 006C	TASK8 C 007D
TASK9 C 008E	TB1 D 02EA	TB10 D 039E	TB2 D 02FE	TB3 D 0312	TB4 D 0326	TB5 D 033A
TB6 D 034E	TB7 D 0362	TB8 D 0376	TB9 D 038A	UREADX D 00B2	UWRITX D 00BC	

ASSEMBLY COMPLETE, NO ERRORS

## SUBMIT File Listing

This listing defines the sequence of operations performed by the MDS in building the firmware. The configuration module is linked with the other RTMTX modules, located at address 40H, and finally converted to a HEX file, which is used to program the PROMs.

```
LINK &
:F1:BOT830.LIB(VECRST), &
:F1:RMX830.LIB(START), &
:F1:RMX830.LIB(SUSPND,RESUME,DLTASK,DLEXCH), &
:F1:CONFIG.OBJ, &
:F1:BOT830.LIB, &
:F1:DFS DIR.LIB(SEEK,DIRECTORY,ATTRIB,DELETE,RENAME,LOAD), &
:F1:DFS DIR.LIB(FORMAT,FORMAT201,FMTTABLE), &
:F1:DIO830.LIB, &
:F1:DFSUNR.LIB, &
:F1:THI830.LIB, &
:F1:THO830.LIB, &
:F1:RMX830.LIB, &
:F1:BOTUNR.LIB, &
:F1:PLM80.LIB &
    TO &
:F1:ROM.OBJ &
    MAP &
    PRINT(:F1:ROMLNK.LST)
LOCATE &
:F1:ROM.OBJ &
    TO &
:F1:ROM.ABS &
    CODE(40H) &
    STACKSIZE(0) &
    DATA(0DC00H) &
    MAP &
    PUBLICS &
    SYMBOLS &
    LINES &
    PRINT(:F1:ROMLOC.LST)
ATTRIB :F1:ROM.HEX W0
DELETE :F1:ROM.HEX
OBJHEX :F1:ROM.ABS TO :F1:ROM.HEX
ATTRIB :F1:ROM.HEX W1
COPY :F1:ROMLNK.LST TO :LP:
COPY :F1:NAME TO :LP:
COPY :F1:DATE TO :LP:
COPY :F1:ROMLOC.LST TO :LP:
```



## Linker Listing

This listing is generated by the object linker and provides a list of all modules included.

ISIS-II OBJECT LINKER V3.0 INVOKED BY:

```
-LINK &
** :F1:BOT830.LIB(VECRST), &
** :F1:RMX830.LIB(START), &
** :F1:RMX830.LIB(SUSPND,RESUME,DLTASK,DLEXCH), &
** :F1:CONFIG.OBJ, &
** :F1:BOT830.LIB, &
** :F1:DFSDIR.LIB(SEEK,DIRECTORY,ATTRIB,DELETE,RENAME,LOAD), &
** :F1:DFSDIR.LIB(FORMAT,FORMAT201,FMTTABLE), &
** :F1:BI0830.LIB, &
** :F1:DFSUNR.LIB, &
** :F1:THI830.LIB, &
** :F1:TH0830.LIB, &
** :F1:RMX830.LIB, &
** :F1:BOTUNR.LIB, &
** :F1:PLMB0.LIB &
** TO &
** :F1:ROM.OBJ &
** MAP &
** PRINT(:F1:ROMLNK.LST)
```

LINK MAP OF MODULE ROM  
WRITTEN TO FILE :F1:ROM.OBJ  
MODULE IS A MAIN MODULE

### SEGMENT INFORMATION:

START	STOP	LENGTH	REL	NAME
		3E7BH	B	CODE
		1275H	B	DATA
		60H	B	STACK
0000H	0002H	3H	A	ABSOLUTE
0008H	000AH	3H	A	ABSOLUTE
0010H	0012H	3H	A	ABSOLUTE
0018H	001AH	3H	A	ABSOLUTE
0020H	0022H	3H	A	ABSOLUTE
0024H	002EH	BH	A	ABSOLUTE
0030H	0032H	3H	A	ABSOLUTE
0034H	0036H	3H	A	ABSOLUTE
0038H	003AH	3H	A	ABSOLUTE
003CH	003EH	3H	A	ABSOLUTE

### INPUT MODULES INCLUDED:

```
:F1:BOT830.LIB(VECRST)
:F1:RMX830.LIB(START)
:F1:RMX830.LIB(SUSPND)
:F1:RMX830.LIB(RESUME)
:F1:RMX830.LIB(DLTASK)
:F1:RMX830.LIB(DLEXCH)
:F1:CONFIG.OBJ(CONFIG)
:F1:BOT830.LIB(IN830P)
:F1:BOT830.LIB(RQBOOT)
:F1:BOT830.LIB(FILNAM)
:F1:BOT830.LIB(RDSECT)
:F1:DFSDIR.LIB(SEEK)
:F1:DFSDIR.LIB(DIRECTORY)
:F1:DFSDIR.LIB(ATTRIB)
:F1:DFSDIR.LIB(DELETE)
:F1:DFSDIR.LIB(RENAME)
:F1:DFSDIR.LIB(LOAD)
:F1:DFSDIR.LIB(FORMAT)
:F1:DFSDIR.LIB(FORMAT201)
```

```

:F1:DFS DIR.LIB(FMTTABLE)
:F1:DIO830.LIB(DISKIO)
:F1:DIO830.LIB(HAN204)
:F1:DFSUNR.LIB(NOFORMAT202)
:F1:DFSUNR.LIB(NOFORMAT204)
:F1:DFSUNR.LIB(NOFORMAT206)
:F1:DFSUNR.LIB(DRIVETIMEOUTVAL)
:F1:DFSUNR.LIB(MINISTARTUP)
:F1:THI830.LIB(THDINI)
:F1:THI830.LIB(ECHO)
:F1:THI830.LIB(STDINP)
:F1:THI830.LIB(PRIINP)
:F1:THI830.LIB(SCANBAUDRATE)
:F1:THI830.LIB(LNEDIT)
:F1:THO830.LIB(THDINO)
:F1:THO830.LIB(CONTROL)
:F1:THO830.LIB(USART8030)
:F1:THO830.LIB(CNTRLTABLE)
:F1:THO830.LIB(MERGER)
:F1:RMX830.LIB(SYNCH)
:F1:RMX830.LIB(RDYLIST)
:F1:RMX830.LIB(DLYLIST)
:F1:RMX830.LIB(OBJMAN)
:F1:RMX830.LIB(SL)
:F1:RMX830.LIB(RMVSLL)
:F1:RMX830.LIB(ENTSLL)
:F1:RMX830.LIB(TB8030)
:F1:BOTUNR.LIB(THRATE)
:F1:BOTUNR.LIB(RESETV)
:F1:BOTUNR.LIB(NODEGR)
:F1:BOTUNR.LIB(FILUNR)
:F1:PLM80.LIB(@P0011)
:F1:PLM80.LIB(@P0014)
:F1:PLM80.LIB(@P0018)
:F1:PLM80.LIB(@P0025)
:F1:PLM80.LIB(@P0029)
:F1:PLM80.LIB(@P0034)
:F1:PLM80.LIB(@P0086)
:F1:PLM80.LIB(@P0091)
:F1:PLM80.LIB(@P0094)
:F1:PLM80.LIB(@P0096)
:F1:PLM80.LIB(@P0098)
:F1:PLM80.LIB(@P0101)
:F1:PLM80.LIB(@P0103)

```

## Locator Listing

This listing is generated by the object locator and provides a complete list of all PUBLIC symbols.

ISIS-II OBJECT LOCATER V3.0 INVOKED BY:

-LOCATE &

\*\* :F1:ROM.OBJ &

\*\* TO &

\*\* :F1:ROM.ABS &

\*\* CODE(40H) &

\*\* STACKSIZE(0) &

\*\* DATA(0DC00H) &

\*\* MAP &

\*\* PUBLICS &

\*\* SYMBOLS &

\*\* LINES &

\*\* PRINT(:F1:ROMLOC.LST)

SYMBOL TABLE OF MODULE ROM

READ FROM FILE :F1:ROM.OBJ

WRITTEN TO FILE :F1:ROM.ABS

VALUE TYPE SYMBOL

0000H	PUB	R?VECRST
0040H	PUB	RQSTRT
00C1H	PUB	RQSUSP
00EFH	PUB	RQRESM
011DH	PUB	RQDTSK
0166H	PUB	RQDXCH
0271H	PUB	RQBAB
0185H	PUB	RQCRTB
0259H	PUB	RQCST
0261H	PUB	RQDCT
026BH	PUB	RQDRC4
0260H	PUB	RQNDEV
044EH	PUB	R?INTDI
03FFH	PUB	R?INTEI
037FH	PUB	R?INTINI
03E7H	PUB	R?LMASK
0463H	PUB	RQDLVL
0448H	PUB	RQELVL
0285H	PUB	RQENDI
0469H	PUB	RQSETV
02F3H	PUB	R?UDPRI
0483H	PUB	RQB00T
0615H	PUB	R?BOTSTR
061EH	PUB	R?R0SECT
0674H	PUB	R?ISEEK
0A6AH	PUB	R?GETBLK
1095H	PUB	R?RLSMAP
0AB0H	PUB	R?MAPDBP
159DH	PUB	R?FILEOPENCHECK
18BAH	PUB	R???DEL
1CE1H	PUB	RQPOPN
1071H	PUB	R?OBTDIR
1382H	PUB	R?ADJEOF
109FH	PUB	R?OBTFCB
160BH	PUB	R?VALIDATEREQUEST
12B2H	PUB	R?PBREAD
149CH	PUB	R?FILENAMECHECK
123BH	PUB	R?DPTTSK
107EH	PUB	R?RLSDIR
0E38H	PUB	R?DIRGET
0C82H	PUB	R?IFREBK
1283H	PUB	R?DBSAVE
0A0DH	PUB	R?ABSIO

16A0H PUB R???IRW  
 0A9CH PUB R?MAPSAV  
 0B22H PUB R?ICLOSE  
 10ACH PUB R?RLSFCB  
 0A93H PUB R?FREBLK  
 0ED8H PUB R?DLOOK  
 0EA0H PUB R?DIRUPD  
 131FH PUB R?CHKEOF  
 1258H PUB R?DBREAD  
 13A2H PUB R?CALLOC  
 12E8H PUB R?PBSAVE  
 18A1H PUB R???RW1  
 1088H PUB R?OBTMAP  
 0AA8H PUB R?MASKARRAY  
 124BH PUB R?CLRBUF  
 0B83H PUB R?IGETBK  
 10B6H PUB RQFDIR  
 141AH PUB R?FITCHPB  
 1D9DH PUB RQFATR  
 1E07H PUB RQFDEL  
 1F21H PUB RQFRNM  
 2199H PUB RQPLD  
 2943H PUB RQPFMT  
 294DH PUB R?FMT201  
 29A8H PUB R?FMTTABLE  
 2A9CH PUB R?REQXCH  
 29CCH PUB R???DST  
 29B0H PUB R???IOW  
 29B7H PUB R???IOR  
 2A13H PUB RQFDSK  
 2A6DH PUB R?SVCDIS  
 2D99H PUB RQHD4  
 2DA9H PUB R?FMT202  
 2DABH PUB R?FMT204  
 2DADH PUB R?FMT206  
 2DAFH PUB RQTQV  
 2DB1H PUB RQMOTM  
 2DC6H PUB R?INPLIV  
 2E0BH PUB RQTHDI  
 2FDCH PUB R??ECHO  
 2FFCH PUB R?STDINPUT  
 30E4H PUB R?PRIINPUT  
 320AH PUB R?SCANBAUDRATE  
 328FH PUB R?SETUPLNED  
 32A4H PUB R?CLEARANDREAD  
 339CH PUB R?LINEEDIT  
 35FEH PUB RQTHDO  
 37A6H PUB R?TESTFORCONTROL  
 37D6H PUB R?PROGRAMTHEUSART  
 381AH PUB RQCTAB  
 3826H PUB R?MERGER  
 395FH PUB R?CONNCT  
 3A56H PUB R?RMVXCH  
 3A65H PUB RQACPT  
 3A89H PUB RQISND  
 399CH PUB RQSEND  
 39C3H PUB RQWAIT  
 3AF8H PUB R?DSPTCH  
 3B27H PUB R?ENTRDY  
 3B74H PUB R?RLINI  
 3B63H PUB R?RMVRDY  
 3C2AH PUB R?CANDLY  
 3C76H PUB R?DLINI

3BAEH PUB R?ENTDLY  
3CASH PUB R?STPDLY  
3D99H PUB R?OBJINI  
3D6EH PUB RQCTSK  
3D75H PUB RQCXCH  
3CE5H PUB R?SETUP  
3DB8H PUB R?ENTSUS  
3DC2H PUB R?RMVSUS  
3DCCH PUB R?RMVSLI  
3E0FH PUB R?ENTSLL  
3E31H PUB R??TICK  
3E5EH PUB R?STRCLK  
3E64H PUB R?STPCLK  
3E6AH PUB R?TCKINI  
3E77H PUB RQRATE  
3E79H PUB R?RST5HD  
3E7CH PUB RQFILE  
3E85H PUB @P0011  
3E87H PUB @P0012  
3E8AH PUB @P0013  
3E92H PUB @P0014  
3E93H PUB @P0015  
3E96H PUB @P0016  
3E97H PUB @P0017  
3E9FH PUB @P0018  
3EA2H PUB @P0019  
3EA9H PUB @P0025  
3EAAH PUB @P0026  
3EADH PUB @P0027  
3EAEH PUB @P0028  
3EB6H PUB @P0029  
3EB8H PUB @P0030  
3ED5H PUB @P0034  
3ED7H PUB @P0035  
3EE9H PUB @P0086  
3EECH PUB @P0087  
3EEDH PUB @P0088  
3EF3H PUB @P0091  
3EF6H PUB @P0092  
3EF7H PUB @P0093  
3F03H PUB @P0094  
3F06H PUB @P0095  
3F0DH PUB @P0096  
3F10H PUB @P0097  
3F17H PUB @P0098  
3F19H PUB @P0099  
3F1CH PUB @P0100  
3F24H PUB @P0101  
3F27H PUB @P0102  
3F2FH PUB @P0103  
3F32H PUB @P0104  
DC00H PUB RQRSTV  
DC68H PUB CNTL1X  
E122H PUB RQDBUF  
DC70H PUB RQL0EX  
DC7FH PUB RQL2EX  
DC8EH PUB RQL3EX  
DC9DH PUB RQL4EX  
DCACH PUB RQL5EX  
DCBRH PUB RQLAEX  
DCCAH PUB RQLBEX  
DCD9H PUB RQLCEX  
E022H PUB RQP00L

DCF2H PUB UREADX  
 DCFCH PUB UWRITX  
 E753H PUB R?ADRXCH  
 E751H PUB R?INITM  
 E73FH PUB R?SIMVEC  
 E769H PUB R?RESPEX  
 E75FH PUB RQBOTX  
 E755H PUB RQLQDX  
 E775H PUB R?SLPMSG  
 E77EH PUB RQNAME  
 E7E6H PUB R?CLSKIL  
 E7F2H PUB R?FREEBUFCH  
 E932H PUB RQOPNX  
 E7DCH PUB RQDIRX  
 E7F0H PUB R?FBLORG  
 E8EFH PUB R?FCBLISTLOCK  
 E903H PUB R?BITMAPLOCK  
 E7FCH PUB R?RETURNBUFCH  
 E8D8H PUB R?DISPTSKSTD  
 E8F9H PUB R?DIRECTORYLOCK  
 E87AH PUB R?ABSIOM  
 E99DH PUB RQATRX  
 E9C0H PUB RQDELX  
 E9E1H PUB RQRNMX  
 EA09H PUB RQLDX  
 EA48H PUB RQFMTX  
 EA7BH PUB R?ENTX1  
 EA7CH PUB RQDSKX  
 EA7AH PUB R?ENT204  
 EA95H PUB RQINPX  
 EA9FH PUB RQWAKE  
 EAA9H PUB RQL6EX  
 EAB8H PUB RQDBUG  
 EAC2H PUB R?LINES  
 EACCH PUB R?LINESS  
 EAD6H PUB R?CHARSS  
 EAE0H PUB R?CHARINPEXC  
 EAEAH PUB R?ECHOEXC  
 ED6DH PUB R?ALARMSS  
 ED77H PUB R?CNTRL  
 ED81H PUB RQOUTX  
 ED8BH PUB RQALRM  
 ED95H PUB RQL7EX  
 EE08H PUB R???RLR  
 EE08H PUB RQACTV  
 EE24H PUB R???DLH  
 EE36H PUB RQL1EX  
 EE60H PUB R???ELR  
 EE4AH PUB R???TLR  
 EE6CH PUB R???SLR

MEMORY MAP OF MODULE ROM  
 READ FROM FILE :F1:ROM.OBJ  
 WRITTEN TO FILE :F1:ROM.ABS  
 MODULE START ADDRESS 0040H

START	STOP	LENGTH	REL	NAME
0000H	0002H	3H	A	ABSOLUTE
0008H	000AH	3H	A	ABSOLUTE
0010H	0012H	3H	A	ABSOLUTE
0018H	001AH	3H	A	ABSOLUTE
0020H	0022H	3H	A	ABSOLUTE
0024H	002EH	8H	A	ABSOLUTE
0030H	0032H	3H	A	ABSOLUTE
0034H	0036H	3H	A	ABSOLUTE
0038H	003AH	3H	A	ABSOLUTE
003CH	003EH	3H	A	ABSOLUTE
0040H	3F3AH	3E9BH	B	CODE
DC00H	EE74H	1275H	B	DATA
EE75H	F6BFH	84BH	B	MEMORY

## APPENDIX C.—TYPICAL HiMAT DISPLAYS

This appendix describes some of the displays used in the HiMAT program.

## Command Interpreter Display

This is the display to which the AIDS executive returns when the user has terminated the previous operation. This display provides the operator with the following information: (1) the version of the AIDS executive, (2) the name and version number of the user module, (3) a list of the available user commands, and (4) a list of the available system commands. The operator enters the desired command, and the corresponding overlay is loaded and executed. A special case is the command "LD" which is used to activate the displays stored on the scratch diskette: (1) the scratch diskette directory is examined to determine the page number of the file specified, (2) the corresponding overlay is loaded, (3) the display templates are copied from the scratch diskette file into the overlay, and (4) the display is activated in refreshed mode.

Hard copy of the HiMAT command interpreter display:

```
AIRCRAFT INTERROGATION & DISPLAY SYSTEM

AIDS-II SYSTEM EXECUTIVE   16 SEPT 1980   R GLOVER

USER LOAD MODULE NAME : HIMAT 8.15.80

USER COMMANDS :
FF MP MC MD MT TX
A1 A2 A3

SYSTEM COMMANDS :
IC TC PC DK LD FD
SIO SMP SMS SMD SMT
```

## Scratch Diskette Directory Display

This display is generated by the AIDS executive in response to a "DK" command. It shows the name of the scratch diskette currently in drive number 1 and lists the contents of each of the 45 available files. The operator has a menu of commands to choose from:

LD	= load a file and present the display in refreshed mode
SAVE	= write the current overlay display into a selected file
INIT	= initialize a new scratch diskette with selected name
DEL	= delete a selected file
NAME	= rename a selected file



# Hard copy of typical HiMAT scratch diskette directory:

```

RESET                                08:18:02
HiMAT 8.15.80                        7.27.81
                                PAGE 201  DIRECTORY FOR SCRATCH DISK HiMAT G. P. 1

FILE PAGE DESCRIPTION  FILE PAGE DESCRIPTION  FILE PAGE DESCRIPTION
  1   3  RATE GYROS    16   3  D/L ST. WDS    31   1  ENG PANEL
  2   3  ACCELS      17   1  DLSN'S      32   3  ENG FAILS
  3   3  PRESSURES   18   3  KEMPEL 3A    33   3  STC THR
  4   3  SURFACES    19   3  P. IN. DISCS  34   3  THR. TEST
  5   3  RADAR ALT   20   3  KEMPEL 3B    35   3  THR. CAL.
  6   3  ATTITUDES   21   3  STRIPCHART    36   3  CAL NOZZLE
  7   3  KEMPEL 1    22   3  D/L TEST      37
  8   3  DUPACTS LC  23   3  ENG TEST      38   3  IPCS SENS
  9   3  LIMCY/B     24   3  PLA TEST      39   4  P MEM CHK
 10   3  SURF CALIB  25   3  PLA TEST      40   4  B MEM CHK
 11   3  DIV COMB    26   3  PLA TEST      41   3  POWER SUPS
 12   3  RAW U/L     27   3  PLA TEST      42   5  C FAIL 1
 13   3  KEMPEL 2    28   3  PLA TEST      43   3  C FAIL 2
 14   3  DL ACT FLS  29   3  PLA TEST      44   3  C FAIL 3
 15   3  DUP ACT FL  30   1  TRUTH          45   5  C FAIL 4

```

COMMAND LIST : LD SAVE INIT DEL NAME

## Tabular Data Display

This display is accessed by the user command "MP" and allows the user to define a display of up to 20 data items. For each item the user must specify item number, data type, hexadecimal address, description, and units. In addition, if the data type is either F1 or F2, the operator must also enter the zero and maximum scaling of the parameter in engineering units. Once created, the display may be saved on the scratch diskette if desired.

## Hard copy of typical HiMAT page 3 display:

```

OPERATE                                08:19:44
HiMAT 8.15.80                          7.27.81
                                PAGE 3  USER-DEFINED DATA DISPLAY

ITEM TYPE ADDR  ZERO (EU)  MAX (EU)  DESCRIPTION  VALUE  UNITS
  1
  2  VG  6125                                PITCH      150.798  DEGREES
  3
  4  VG  6131                                ROLL       148.776  DEGREES
  5
  6  DG  61BA                                YAW        331.260  DEGREES
  7
  8  E0  6131                                90 D ROLL   ZERO
  9
 10  DV  629D                                SPECIAL OP  -0.020  VOLTS
 11
 12  E1  61DB                                UMB NOT SE  ONE
 13  E3  61DC                                LAN NOT SE  ONE
 14
 15  F2  6094      0.000    100.000  MIDV PR      0.098  DEG/SEC
 16  F2  6096      0.000    100.000  MIDV YR     -0.049  DEG/SEC
 17
 18  E0  61D7                                FAST ERECT  ZERO
 19
 20  E4  61D8                                PRI MODE    ZERO
DISK : HiMAT G. P. 1  FILE NO. 6  FILE NAME : ATTITUDES

```

## Block Memory Dump Data Display

This page format is accessed by command "MD" and allows the operator to display in hexadecimal format up to 304 bytes in a single block. The operator must specify the beginning and ending addresses of the block. The display may be saved on scratch diskette file if desired.

Hard copy of typical HiMAT block memory dump display:

OPERATE  
HiMAT 8.15.88

08:23:00  
7.27.81

PAGE 5 MEMORY DUMP

61D7	40 00 00 00	33 08 00 C7	30 00 01 00	00 00 80 00
61E7	92 04 00 00	88 A0 01 00	00 00 00 40	48 00 00 80
61F7	80 4D 11 00	80 00 E0 80	40 00 06 08	1C 4D 80

DISK : HiMAT G. P. 1    FILE NO. 42    FILE NAME : C FAIL 1

## Free-Form Data Display

This display mode is accessed by the user command "FF" and allows the operator to create unstructured displays in any format desired. Separate commands are available to allow creating the static or background portion of the display, followed by the insertion of data items in any desired format at any location of the screen. Once created, the display may be saved on scratch diskette if desired.

Hard copy of typical HiMAT free-form data display:

OPERATE  
HiMAT 8.15.80

PAGE 1

08:21:12  
7.27.81

# ENGINE PANEL

14.422 (PSI)			
COMPRESSOR DISCHARGE PRESSURE	PLAD = 15.000 DEG PLAC = 0.000 DEG		
10.000 (%)	0.000 (C)	99.996 (%)	0.000 (DEG)
RPM	EXHAUST GAS TEMPERATURE	EXHAUST NOZZLE AREA	THROTTLE POSITION
CONTROL MODE IGNITION		ENGINE STABILITY HIGH	NOZZLE CONTROL OVERRIDE
ZERO		ZERO	ZERO
DISK : HiMAT G. P. 1 FILE NO. 31 FILE NAME : ENG PANEL			

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[illegible]